DOCUMENT RESUME

ED 074 767 EM 010 965

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TITLE Conjugate Reinforcement.
INSTITUTION Syracuse Univ., N.Y. Computer Based Project.
REPORT NO CBP-SU-RR-7222
PUB DATE Apr 73
NOTE 16p.; Paper presented at the Association for Educational Communication and Technology Annual Conference (Las Vegas, Nev., April 1973)

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS *Attention Control; Attention Span; Audiovisual Aids; Computer Assisted Instruction; Experimental Psychology; *Measurement Instruments; *Reinforcement; *Stimulus Behavior

ABSTRACT

Conjugate reinforcement is a new attention measure which has emerged from experimental psychology. It can provide accurate measurement of a subject's attention to a stimulus. In conjugate reinforcement, the duration of the stimulus varies directly and immediately with the subject's rate of response. In this process, the subject must demonstrate his attention continuously by pressing a small key at a required rate to maintain the presentation of the stimulus. This paper provides a brief introduction to the techniques. It discusses the background of the reinforcement system, defines the concept, and describes a series of procedures in which it has been used. It also explains applications of the procedures and describes the advantages of the technique. The technique is useful in helping to explain how learning from audiovisual aids takes place. (Author/JK)

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CONJUGATE REINFORCEMENT

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EM 010 965

Presented as part of a Computer Based Project Symposium at the AECT/ASET Conference, Las Vegas, Nevada, April, 1973.

Research Report 7222
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CBP - SU
December, 1972

CONJUGATE REINFORCEMENT

Learning from audio-visual materials is a complex procedure not completely understood by researchers. Many learning theories which attempt to describe the learning process have segmented learning into various steps. In learning from audio-visual media, one step which appears to be most important is attention. (Lewis, 1972) Attention is seen as a behaviorally emitted response which increases a subject's contact with the stimulus and which can be functionally related to that stimulus. Many measures of attention have been used by researchers. Some, include eye movements and bodily orientation responses.

This paper describes a new attention measure which has emerged from experimental psychology, called conjugate reinforcement. In conjugate reinforcement, the duration of the stimulus varies directly and immediately with the subject's rate of response. In the conjugate reinforcement procedure the subject must demonstrate his attention continuously by pressing a small key at a required rate to maintain the presentation of the stimulus.

The object of the paper is to provide a brief introduction to conjugate reinforcement, its value and its relationship to the objectives of the Computer Based Project. The paper follows the following format. At the outset, the background of the conjugate reinforcement system is discussed. Then, conjugate reinforcement is defined, and a series of procedures which have been used are described. The purpose of this section is to give the reader some idea of the methods in which the procedure may be used. A review

of related literature shows the application of the procedure. Then the relationship of conjugate reinforcement procedure to other measures of attention is provided followed by a section on the advantages and uses of the conjugate procedure. Finally, the applications of the procedure to the project are delineated.

BACKGROUND

The conjugate reinforcement procedure has its roots in operant psychology, particularly the type fostered by B. F. Skinner (1953). One of Skinner's basic principles of learning is that a reinforced response has a higher probability of re-occurrence than a non-reinforced response. In traditional operant conditioning studies, a specific response such as a bar press is reinforced by giving the subject a primary reinforcer such as food or candy (Reese, 1966). The subject is reinforced on a definite schedule of reinforcement, such as Fixed Ratio 3 (FR 3) schedule in which every third response is reinforced (Ferster and Skinner, 1957).

Lindsley (1956) and Baer (1960) using Skinner's techniques showed that subjects would respond to maintain the presence of pictures. In these studies no primary reinforcers (food) or secondary reinforcers (praise) were used. The only reinforcement for maintaining the picture was the picture itself; i. e., the picture served both as stimulus and reinforcement. Once it was determined that pictures had reinforcing value, the conjugate reinforcement procedure was developed.

DEFINITION OF CONJUGATE REINFORCEMENT

In conjugate reinforcement the presentation time of the stimulus varies directly and immediately with the subject's rate of response. For example, if the stimulus is a slide and the response is a button press, a number of presses, e. g. 60 per minute, will keep the stimulus visible all the time. A rate of 40 responses per minute will keep the stimulus visible only 66% of the time. Lindsley (1962) notes that the continuous reinforcement available with the conjugate reinforcement system permits a finer analysis than the former episodic reinforcement schedules e. g., the FR 3 mentioned above.

Bijou and Baer (1965) note that the technique may be ideal for measuring attention since variations in the stimulus may be accompanied by variations in the response rate.

PROCEDURES

In a typical conjugate reinforcement procedure, the subject first enters a controlled environment which seeks to eliminate extraneous stimuli. He sits in a comfortable chair and the response unit is demonstrated. Response units have varied from a push-button microswitch to a foot pedal. The conjugate programming apparatus is set to the actual number of presses that are required to maintain constant presentation of the stimulus. Each time the subject presses the button, the stimulus will be presented for the fixed period of time. The stimuli are now presented and the rates of response recorded using a cumulative recorder.

After the session, the records are examined to determine the stimuli which were accompanied by high attention and those which were accompanied by low attention. A high rate indicates high attention while a low rate shows low attention. Many studies have sought to validate the information obtained using conjugate reinforcement procedures by asking for verbal reports of preferance from the subject or by administering tests which seek to measure the recall of the stimuli.

Two types of conjugate reinforcement procedures have been reported in the literature: the simultaneous and the sequential procedure. In the sequential system, two stimuli are presented successively. Lindsley (1962) used a sequential system to evaluate television programs and commercials. He compared the effectiveness of each section of the program by comparing the

response rate to a baseline performance or to other sections of a program. Nathan and Wallace (1965) compared two television commercials using a sequential system. Both commercials were presented to the subject at different times in the same program. Response rates to each were recorded and compared to determine the effectiveness of each commercial.

In a simultaneous system, both stimuli are available. This technique is useful where only two items are to be compared. By contrast the sequential system can handle two or more items. Morgan and Lindsley (1966) used a simultaneous procedure to compare the reinforcing value of stereo of monophonic music. Two response units were provided. Responses on one unit produced stereo music while responses on the other unit produced monophonic music. They found that stereo was preferred by half of their subjects.

REVIEW OF RELATED LITERATURE

Table 1 summarizes some of the studies that have been conducted using conjugate reinforcement. In this section, only studies with direct relevance to mediated materials will be reviewed in detail.

Lindsley (1962) measured the reinforcing effects of the visual and auditory sections of a television program and commercials. The subject pushed a small switch either to illuminate the screen or to hear the soundtrack. Response rates of above 60 per minute kept the stimulus at full intensity while lower rates presented the stimulus at a lower intensity. Subjects responded differentially to commercials, a television show and a film. In addition, differential responding to sections of the stimuli was observed. Lindsley noted that the response could be likened to an artificial pupil which the subject could open or close by pressing the button. Other applications of the technique proposed by Lindsley include interprogram comparisons and

choices of technical procedures to be used in the design of mediated materials.

Nathan and Wallace (1965) modified Linsley's conjugate reinforcement technique in three ways: 1. subjects pushed foot pedals to provide cumulative records of both looking and listening responses made to produce the stimuli. Looking and listening responses were collected simultaneously; 2. the stimulus presentation instrumentation was re-designed to permit the presentation of slides, television programs and sound motion pictures; 3. the response rate and force required to respond were adjusted for each individual by determining his baseline performance. Stimulus material presented consisted of a football game with four commercials interspersed. Results showed that the occurrence of the looking and listening responses were correlated; i. e., when a subject responded to look, he also responded to listen.

Friedlander used the PLAYTEST, a simultaneous conjugate system to determine children's and infants' preferences for speaker identity, voice inflection, and message redundancy (1968). In a later experiment (Friedlander, 1969) he measured children's discrimination of four loudness levels of natural sounds. Other studies by Friedlander investigated stimulus degradation (1970a) loudness and sound frequency (1970b) and word order (1971) on operant preferences of children.

Winters and Wallace (1970) summarize conjugate studies and conclude that the technique is "...(1) a reliable and valid measure of attention and interest. (2) the sensitivity of the technique can be enhanced by building choice into the stimulus situation. (3) the technique can predict attention wearout

and recall. (4) it is not a solution to all attitude change problems and (5) more research is needed..."

RELATIONSHIP TO OTHER MEASURES OF ATTENTION

Many procedures for measuring attention have been suggested i. e. eye movements, body movements and physiological measures. However, these procedures merely specify a set of behaviors that accompany attention. The antecedant conditions are not specified. None of these measures require a subject to emit a response to maintain the presentation of the stimulus. The problem with this is that it is difficult to infer attention from one of these responses such as eye movement. If a subject has his eyes on the screen is he attending? He may be and yet there is no response specified to show that he is attending, i.e. the stimulus may be reaching his receptors, but the experimenter does not know if it is going any further.

The conjugate reinforcement system requires a subject to demonstrate his attention continuously. There is an empirical record of responses made in the presence of certain stimuli. With the conjugate system the other sets of behaviors can be related to the stimulus more readily than if no empirical measure of responding to the stimulus was available. For instance, if a subject maintains responding to a murder scene on a film and during that scene his pupils dilate, his heart rate increases, his Galvanic Skin Resistance decreases, and his respiration rate quickens, it can be presumed that the subject's responses were made to that stimulus. Without the empirical measure provided by the conjugate system, the stimulus being attended is difficult to specify.

Commercial broadcasters (Peatman and Hallonquist, 1945 and others) have specified responses which a subject can make to demonstrate his preference

or liking for a stimulus. The subject is asked to demonstrate his preference by pushing a button marked "like" or "dislike". Other researchers have asked the subject to turn a knob in either direction to demonstrate "like" or "dislike".

These methods have several shortcomings. One is that the experimenter cannot specify what the response means. He cannot specify the antecedant conditions. The experimenter does not know whether the subject is responding to the preceeding stimulus or to the words "like" and "dislike". The experimenter has an empirical measure, but he cannot specify what that measure is. The systems described above have been used for many years and have a great deal of validity, i. e. programs that have tested well in pre-release testing using preference techniques have been received well.

However, in the long run, the commercial broadcaster and others using this technique want to know if the subject will continue to attend or will switch programs or turn off the set. The conjugate reinforcement system provides an empirical measure of just that - the degree to which the subject will respond to maintain the presentation of the stimulus. The problem of interpreting what the subject meant by "like" is surmounted.

The variable measured by the conjugate reinforcement system can be exactly specified i. e. the subject responded to maintain this stimulus and did not respond to maintain that stimulus. Like the preference techniques, the measure is continuous and sensitive. However, unlike these techniques the conjugate system requires the subject to respond in order to maintain the stimulus. In the preference techniques there is no requirement that a response be emitted at any time. The response of the subject has no effect on the presentation of the stimulus as in the conjugate system.

ADVANTAGES AND USES OF THE CONJUGATE TECHNIQUE

The conjugate reinforcement technique is useful for several reasons. It provides a continuous, sensitive, behavioral measure of a subject's responses to maintain a stimulus. This gives the experimenter an index to what is being perceived by the subject and what is being accepted by his cognitive system i. e. the experimenter can refer to the measure as an artificial pupil which the subject can open or close by pressing a button. It has been difficult in the past to get any measure on other processes which may occur in perception and attention. The conjugate system gives some measure of those processes.

In addition, the conjugate system can be adjusted for each subject. If a subject responds at a uniform rate to a stimulus presentation, the response cost can be increased so that more effort is required to emit a response. In this manner an experimenter can empirically determine the value of parts of the stimulus presentation to the subject.

The effect of captions on attention and learning has long been debated. With a conjugate system, it would be possible to get an empirical measure of responding to produce captions. The subject can control the presentation of the captions instead of the picture or sound. The result is an empirical measu of not only whether the caption was produced, but the duration of the responding Thus, an accurate measure of how long a caption needs to be presented is available.

The conjugate reinforcement system appears to be a valuable method of determining or measuring the attention given to any stimulus. It provides an empirical behavioral external measure that gives an index to the other

processes which occur in viewing.

With the construction of an experimental enclosure which provides a controlled environment, the possibility of conducting research using the conjugate procedure has become a reality at Computer Based Project. The next section suggests some studies which may be conducted.

At CBP, researchers have designed and pilot-tested a sequential conjugate reinforcement apparatus which has been used to measure the effect of several stimulus variations (color and degree of realism) on attention (Lewis, in preparation). Subjects are trained to emit the required 40 responses per minute. Then, the stimuli are presented and the variations in attending behavior noted. Later analysis shows which stimuli were attended and to what degree.

APPLICATIONS TO CBP

The conjugate technique and apparatus can be used for studies on the following:

1. Moment to moment evaluation of films used at CBP. This data could be added to the body of evaluation data on each film or sent to the producers of the film. In this application, the varying rates of response to each section of the film would demonstrate that section's ability to maintain the attention of the subject.

2. Filmstrips can be evaluated. The strip would be programmed to procede at its normal rate i. e. the subject would not be able to control the frame advance apparatus. However, the subject would be able to control the presentation of the stimulus. Either the audio soundtrack or the pictures could be placed under the subject's control. The attention-maintaining ability of the stimuli could thus be determined.

3. Studies on the effect of captions. The optimal presentation time of captions could be determined by placing the presentation of captions under the control of the subject. In this application, pushing the button would present the captions. Records would show when the captions were produced and for how long.

4. Studies on complexity of captions could be conducted. In this situation, two captions for the same picture would be presented to two groups of subjects. The caption eliciting the higher response rate would be judged superior.

5. Studies on the effect of other stimulus variations are also possible. Complexity, novelty, congruity, affective tone and degree of action are some of the stimulus properties that could be evaluated regarding their effect on attention.

6. The effect of a response set on attention can be determined. A typical response set might be knowledge of a post-test or some reward for emitting the response.

7. Finally, studies on the effects of varying soundtracks on attention could be conducted. Variations in the music, age level of narrator, natural versus, real sound and sound effects are possible areas of investigation.

SUMMARY

This paper has provided an introduction to conjugate reinforcement, a technique which can provide accurate measurement of a subject's attending behavior. The technique was described, some applications discussed and some implications for the project were proposed. It is proposed that the project design and conduct experiments using the conjugate reinforcement procedures.

TABLE I Applications of the conjugate reinforcement technique

Experimenter(s)	Subjects	Stimuli	Method	Results
Lindsley (1957)	2 adult males sleep deprived.	Aversive tone to be avoided.	Closing switch between finger and thumb stopped tone for a period of time.	Depth of sleep could be determined since the technique discriminated between level.
Baer (1960)	Pre-school 4-6 years.	Movie.	Pressing a bar postponed withdrawal of stimulus.	Children will respond to keep stimuli on the screen.
Lindsley et. al. (1961)	Patients undergoing operative procedures.	Tone to be avoided.	Pressing switch would postpone tone. To determine speed of recovery from anesthesia.	Different types of anesthetic produced different records of avoidance.
Lindsley (1962)	Male adult.	Film and TV commercials.	Audio continuous, Video under S's control. 60 rs/min required to maintain video.	Commercials elicited lower rate than film.
	Female adult.	TV show commercials.	First video under S's control, then audio. 60 rs/min. required to maintain.	Some sections not watched. No commercials watched.
Nathan & Wallace (1965)	33 adults.	Football game with commercials.	Push foot pedals to maintain audio and video. Base-line determined (for rate).	Audio and video rates were similar. Comm's lower by 10%.

TABLE I Applications of the conjugate reinforcement technique (cont'd.)

Experimenter(s)	Subjects	Stimuli	Method	Results
Morgan & Lindsley (1966)	High school students and nurses.	Mono & stereo music.	One button produced mono music, the other stereo. Then, mono first, then stereo.	2 S's showed pref. for stereo, 2 did not. Both techniques have value.
Lipsitt et. al. (1966)	44 1 yr. old S's.	Clown in a light box.	Large panel pushed to present clown for a time. Conditioning and Ext. per. used.	Rate was higher during conditioning periods than during extinction.
Lovitt (1966)	7-12 yr.	2 stories	One story on, the other available by pressing handswitch. Fixed rate req. to maintain second story. Verbal pref's after.	Operant preferences were the same as the verbal responses.
Palmer et. al. (1968)	Pre-school	TV shows	Stimulus dimmed after 15 secs. Button press brought it back. Came back automatically after 15 secs.	Button presses not related to other measures for control groups. Children could not use butt.
Lindsley (1969)	Psychiatric patient	Therapist	Button press to see and hear therapist for definite amount of time.	Diff. rates using diff. psych's, diff. speech and depending on S's emotional state.

TABLE I Applications of the conjugate reinforcement technique (cont'd.)

Experimenter(s)	Subjects	Stimuli	Method	Results
Friedlander (1970)	10 infants	Audio stimuli. Music at 2 levels.	2 knobs. One produced one level the other, the other.	Infants preferred the higher volume.
(NOTE: Friedlander has reported many other studies evaluating other types of audio stimuli)				
Berlyne (1972)	College S's	3 pairs of 2 stimuli. 1 complex, one simple.	VI schedule on 2 keys. One prod. simple, the other complex for five seconds.	More complex viewed more than simple.

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